§13. Method of Fabricating Natural Radiation Source

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Materials containing such naturally occurring radioisotopes are termed natural-radioisotope-containing materials. Some examples of materials of this type are potassium chloride, monazite, sinter (hot spring deposit), and dried seaweed. In the present study, a method of fabricating a radiation source with natural-radioisotope-containing materials has been developed for use in a radiation protection course aiming to enable better comprehension of the characteristics of radiation and the principles of radiation protection. Using this method, a radiation source was formed by compressing and forming potassium chloride into disks. The compressing and forming method does not affect the amount and concentration of radioactivity in the material. The method only reduces the volume of the original material and does not affect the weight or radioactivity thereof. The performance of the method of fabricating the potassium chloride radiation source was inspected.

1) Compressing and forming method

The setup of compression devices and apparatuses is schematically shown in Fig. 1. By consistently using this

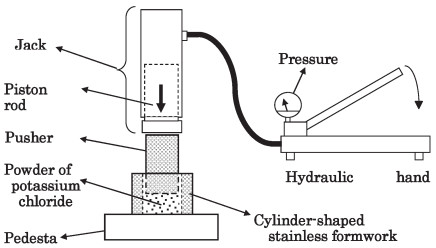

Fig. 1 Schematic view of experimental setup for compressing potassium chloride powder with a jack and hand pump

method, thirteen sources were fabricated and examined with respect to their weight, mass density, thickness, and radioactivity via the count rate. The weight was measured with a direct-reading balance, and the thickness with a vernier micrometer. The thickness varied little with respect to different measuring positions on the source (less than a few percent) and an accurate value of thickness was determined through measurements taken at several positions on the source. The count rate was obtained by 30-minute integration in which a source was appressed to the center of the head surface of the probe of a GM survey meter

The obtained results are shown in Fig. 2. The x-axis shows reference numbers corresponding to the thirteen sources, and square, rhombus, circular, and triangular symbols denote the weight, thickness, mass density, and count rate of each source, respectively; the average values are 29.75 g, 1.56 cm, 1.97 g/cm^3, and 393.7 cpm, respectively. The relative standard deviations (RSDs) are less than 1% for the first three average values and approximately 1.16% for the average count rate.

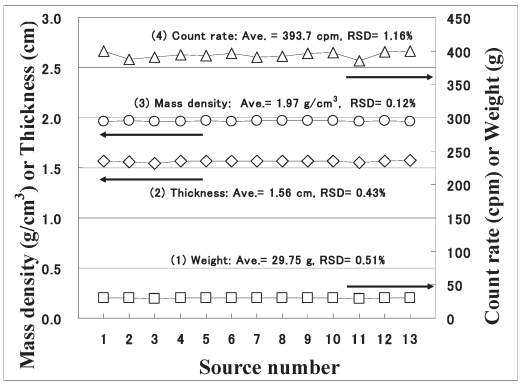

Fig. 2 Performance of compressing and forming method

2) Uniform compression

The thickness of the natural radiation source formed of potassium chloride may vary depending on the amount of powder and pressing pressure used. In the present study, the pressing pressure was approximately 160 kN and the thickness is proportional to the amount of powder used, if the powder is uniformly compressed. Uniform compression is very important for ensuring that radioactivity is uniformly distributed over all parts of the thus-fabricated source. To confirm this, six sources were fabricated using 3, 5, 10, 15, 20, and 30 g of potassium chloride, and the relationship between the thickness of the fabricated sources and the original amount of potassium chloride was examined. Figure 3 shows the linear relationship between the thickness and the amount of potassium chloride (weight in Fig. 3), illustrating that the compressibility ratio is constant, independent of the amount of material used and from this result, it can be assumed that the radioactivity distribution is also uniform over the source.

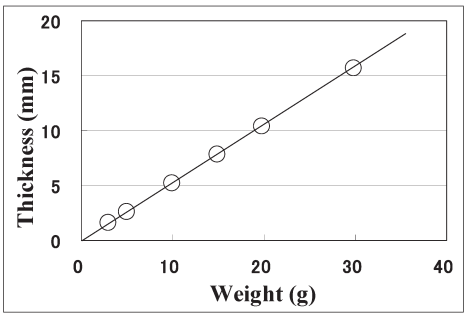

Fig. 3 Dependence of source-thickness on amount of material

On the basis of the above results, the compressing and forming method is considered to be suitable for fabricating numerous uniform natural radiation sources with potassium chloride.